PATENT CLAIMS

1. A method for characterizing a culture liquid, in particular in a bioreactor, in which by illuminating the cells (22) contained in the culture liquid the culture liquid is analyzed in situ, microscopic imaging of the cells (22) and by evaluating the image, characterized in that the illumination is carried out as dark-field illumination, and in that the image evaluation comprises a comparison of the intensities of the light output by the interior of the cell and by the edge of the cell, by means of which comparison living and dead cells (22) are distinguished in order to determine the vitality of the culture liquid.

2. The method as claimed in claim 1, characterized in that a bright-field illumination is carried out apart from the dark-field illumination.

3. The method as claimed in claim 1 or 2, characterized in that an illumination for fluorescent excitation is also carried out, and the image evaluation comprises an observation of the fluorescent light output by the cells (22).

4. The method as claimed in one of claims 1 to 3, characterized in that an interference contrast observation of the cells (22) is also carried out.

5. The method as claimed in one of claims 1 to 4, characterized in that a phase contrast observation of the cells (22) is also carried out.

6. The method as claimed in one of claims 2 to 5, characterized in that differently polarized light is used for various types of illumination, and the images that are produced by the various types of illumination are distinguished with the aid of the different polarizations of the light producing the images.

7. The method as claimed in one of claims 2 to 6, characterized in that light of different wavelengths is used for various types of illumination, and the images that are produced by the various types of illumination are distinguished with the aid of the different wavelengths of the light producing the images.

8. The method as claimed in one of claims 1 to 7, characterized in that the illumination is carried out with pulsed light.

9. The method as claimed in one of claims 1 to 8, characterized in that a sample volume (16) of the culture liquid that is to be imaged is temporarily immobilized during imaging for the purpose of image evaluation.

10. An apparatus for characterizing a culture liquid, in particular in a bioreactor, having an illuminating arrangement (24) for illuminating a sample volume (16) of the culture liquid, a microscope objective (18) for imaging cells (22) inside the sample volume (16), and an image-evaluating device (20) for analyzing the image, characterized in that the illuminating arrangement (24) is provided for dark-field illumination, and the image-evaluating device (20) is designed for comparing the intensities of the light output by the interior of the cell and the edge of the cell, and for distinguishing living and dead cells on the basis of this comparison.

11. The apparatus as claimed in claim 10, characterized in that the illuminating arrangement (26), the microscope objective (18) and the image-evaluating device (20) are arranged inside a tube (10) whose wall is provided with openings for the culture liquid to flow through the sample volume (16).

12. The apparatus as claimed in claim 11,

characterized in that the thickness of the sample volume (16) is limited by two glass plates (12, 14) at right angles to the optical axis of the microscope objective (18), of which at least one plate can be shifted along the optical axis.

13. The apparatus as claimed in claim 11 or 12, characterized in that the tube (10) is provided with devices for closing the openings in order to immobilize the sample volume (16).

14. The apparatus as claimed in one of claims 10 to 13, characterized in that the illuminating arrangement (24) is provided for pulsed operation.

15. The apparatus as claimed in one of claims 10 to 14, characterized in that the illuminating arrangement (24) is also designed for bright-field illumination.

16. The apparatus as claimed in one of claims 10 to 15, characterized by a fluorescent light source (42) for fluorescent excitation of the culture liquid, the image-evaluating device (20) being provided for analyzing the fluorescent light output by the cells (22).

17. The apparatus as claimed in one of claims 10 to 16, characterized by a first Wollaston prism (58), arranged in the beam path of the illuminating arrangement (24), and a second Wollaston prism (60), arranged in the imaging beam path, for interference contrast observation of the cells (22).

18. The apparatus as claimed in one of claims 10 to 17, characterized by an annular diaphragm (52) arranged in the beam path of the illuminating arrangement (24), and a phase plate (60), arranged in the imaging beam path, for phase contrast observation of the cells (22).

19. The apparatus as claimed in one of claims 10 to 18, characterized in that polarization devices (24) are arranged in the beam path of the illuminating arrangement (24) and/or of the fluorescent light source (42), and polarization-selective devices (44) are arranged in the imaging beam path.

20. The apparatus as claimed in one of claims 10 to 19, characterized in that monochromatizing devices (24, 50) are provided in the beam path of the light emanating from the illuminating arrangement (24) and/or the fluorescent light source (42), or the light sources (26, 46) are themselves monochromatic, and in that wavelength-selective devices (44) are arranged in the imaging beam path.

21. The apparatus as claimed in claim 19 or 20, characterized in that provided as polarization- or wavelength-selective device is a beam splitter (44) that passes light of a first polarization or wavelength for the purpose of imaging on a first image recorder (20), and reflects light of a second polarization or wavelength on a second image recorder (42).